

MATHS 208 is a 15-point sequel to MATHS 108, consisting of three parts:

**Calculus:** Multivariable calculus and optimisation, integration techniques, sequences, series,

**Algebra:** Linear and matrix algebra, vector spaces, orthogonality, least-squares and eigenproblems.

**Differential equations:** An introduction to 1st and 2nd-order differential equations

It is designed to provide an understanding of many of the mathematical principles and methods involved in more advanced subjects in Commerce, Operations Research, Computer Science (graphics) and Physics.

**Pre-requisites and Restrictions:** Students entering this course should have a pass in one of MATHS 108, MATHS 150, MATHS 151, MATHS 153, ENGSCI 111 and PHYSICS 111.

*Note:* Students who have passed MATHS 108 with a B+ or better and who intend to advance in Mathematics are advised to take MATHS 250 rather than MATHS 208.

**Aims** After successfully completing the course, a student should be able to:

- calculate partial derivatives using the chain rule and implicit differentiation,
- classify critical points via the positive definiteness properties of the Hessian,
- use the method of Lagrange multipliers to solve constrained extrema problems,
- apply convergence tests to sequences and series, manipulate power series, and estimate functions using Taylor polynomials,
- use substitution and integration by parts to evaluate integrals,
- understand the basic theory of vector spaces, including the notions of linear independence, span, basis, dimension and subspace,
- identify the subspaces of  $\mathbb{R}^n$  defined by a matrix,
- use the Gram-Schmidt algorithm to obtain an orthonormal basis from any given basis for a vector space,
- calculate least-squares solutions of over-determined linear systems,
- calculate eigenvalues and eigenvectors of small matrices, estimate them using power and inverse power methods, and apply them in the analysis of discrete dynamical systems,
- classify ordinary 1st- and 2nd-order differential equations and solve them using an appropriate method,
- use eigenvalues and eigenvectors to solve a 2nd-order linear homogeneous DE as a system of first-order equations.

### Lecturers & Contacts

Stream	Weeks	Lecturer	Office	Phone	email
11:30-12:30 721-201 Tamaki	1-12	Alastair McNaughton	731.330 Tamaki City: 330 Maths	85244 88762	a.mcnaughton@auckland.ac.nz
4-5 PLT1 City	1-6 7-12	Wiremu Solomon Anita Kean	209 Stats 323 Maths	88771 88742	w.solomon@auckland.ac.nz a.kean@auckland.ac.nz
5-6 MLT2 City	1-6 7-12	Joel Schiff Chris King	312 Maths 412 Maths	88778 88818	j.schiff@auckland.ac.nz c.king@auckland.ac.nz

- Lecturers' office hours are posted on Cecil: see Knowledge Map.
- The course coordinator is Anita Kean.

**Weekly schedule:** The course will consist of 3 hours of lectures and 1 hour of tutorial per week.

Lectures are held Mondays, Tuesdays & Wednesdays, weeks 1-12 of the semester.

Tutorials are held on Thursdays, weeks 1-12 of the semester.

Tutorial rooms and times are posted on Cecil: see Knowledge Map. See nDeva for your tutorial enrolment.

## Lecture Schedule

### Part 1. Calculus (14 1-hour lectures)

- L1 Revision of partial derivatives
- L2: Chain rule and Implicit differentiation
- L3: Gradient and Directional Derivative
- L4: Hessian matrices, classifying critical points via the positive definiteness properties of the Hessian
- L5: The geometric interpretation of the method of Lagrange multipliers and example
- L6: Further examples including two constraints (two Lagrange multipliers).
- L7: Limit-taking techniques of sequences: the Squeeze theorem
- L8: Limit-taking techniques of sequences: L'Hopital's rule
- L9: Partial sums and Geometric series
- L10 Local Approximation - Taylor Polynomials
- L11 Taylor Series: Ratio test for convergence of Taylor Series at a point
- L12 Taylor series
- L13 Review of integration, including integration by substitution
- L14 Integration by parts

### Part 2. Algebra (14 1-hour lectures)

- L15: Vectors - introduction, linear combinations, linear independence and dependence of a set of vectors using reduced echelon form.
- L16: Relationship between linear independence and rank. The span of a set of vectors.
- L17: Vector spaces. Basis and dimension. Euclidean vector spaces  $\mathbb{R}^n$ . Subspaces of  $\mathbb{R}^n$ .
- L18: Matrices and the subspaces they define: Nullspace and Column Space. The relationship between rank and nullity.
- L19: Nullspace of a matrix, and the general solution of a linear system.
- L20: (Anzac day. No lectures.)
- L21: Orthogonal bases, orthogonal matrices, the orthogonal projection of a vector onto a line.
- L22: Orthogonal projection of a vector onto a plane, the Gram-Schmidt procedure for obtaining an orthogonal basis for a subspace.
- L23: Fitting data to a line, solving inconsistent systems of equations using the method of Least Squares.
- L24: Determinants: by cofactor expansion and row-reduction. Introduction to eigenvalues.
- L25: Eigenvalues & eigenvectors: - the characteristic equation, eigenspaces of a matrix, and diagonalisation of a matrix.
- L26: Symmetric matrices - orthogonal diagonalisation. Quadratic forms and associated matrices. Positive-definite quadratic forms and matrices.
- L27: Markov Chains, steady states.
- L28: Discrete Dynamical Systems - their solution by eigenvector decomposition of state-space, and the long-term outcome.

### Part 3. Differential equations (8 1-hour lectures)

- L29: Introduction to DEs, examples, terminology.
- L30: Solving 1st order DEs by separation of variables
- L31: Solving 1st order linear DEs by using an integrating factor
- L32: Slope fields and Euler's method
- L33: 1st order systems and their solutions
- L34: Solutions and the superposition principle
- L35: linear independence of functions and the Wronskian
- L36: solving using the characteristic equation

## Resources

**Lecture Notes** for the course are available from the University Book Store for \$18, and from Cecil as a single download. The lecture notes will be followed in class - they have write-in space for worked examples, and references to further reading and exercises from the course texts.

**Texts** There are two required texts for the course:

- Calculus: Early Transcendentals, 8th Edition, by H. Anton, I Bivens, S Davis (Wiley).
- Contemporary Linear Algebra, H. Anton, R. Busby (Wiley).

They are available at the University Bookshop (city and Tamaki campus) and VOL 1 Bookshop, 33 Symonds St. They are sold as a shrinkwrapped pair for \$162. Second-hand copies may also be available. These texts are also the required texts for MATHS 150/108/250/253.

**Text Publisher's Web site.** Students using the Anton texts have the publisher's permission to visit and use the following companion Web site: <http://www.wiley.com/college/anton>  
The Department of Mathematics encourages you to visit this site and use any material available there.

**Previous Coursework** Assignments, tests and exams from 2006, along with their solutions, are available for download from the Cecil Knowledge Map (under Previous Coursework).

## Technology

**Matlab** The software package Matlab is used in many undergraduate mathematics courses.

**Purchase** A student-version of Matlab is available for \$73 from the Student Resource Centre in the Basement of the Maths building. This allows you to install and run Matlab on your own computer (Windows/Mac/Linux).

**Lab Availability** Matlab is available for you to run in the following computer labs:

- (a) Mathematics/Statistics/Computer Science Basement Computer lab, B91 (9-8, Mon-Thur, and 9-5 Fri). Matlab demonstrators are available at these labs.
- (b) Student Commons.
- (c) On weekends, Maths students may use the Computer Science labs rm303.130, rm 303.191, rm 303.G91 in building 303S (9am - 8.45pm).

**General Matlab help** is available from <http://www.auckland.ac.nz/matlab/>

**208 Tutorials** Three self-paced Matlab tutorials form Maths 208, one each on Calculus, Linear Algebra and Differential Equations, will be made available on Cecil in weeks 1, 5 and 10 respectively).

**208 Coursework book** Small Matlab code segments appear throughout the lecture notes as applications of course material. They are also available for download from Cecil. You are encouraged to extend them.

**Assessment** Matlab will not be examined in the 208 mid-term or final exam, but you may be required to use it in your assignments.

**Calculators** *will be permitted in the mid-term test and final examination.*

**Formula sheets** will *not* be provided in tests or examinations.

**Expectations:** Semester courses at the University of Auckland are assumed to use 10 hours of student time per week. In this course the normal pattern of student study is expected to be (each week):

- (i) 3 hours lectures
- (ii) 1 hour tutorial
- (iii) 6 hours lecture preparation/revision and assignment/test preparation.

- Students are expected to attend all lectures and tutorials, and to come to class prepared. This means that you will have previewed the material in the text and done any preliminary examples that have been set.
- NOT ALL COURSE MATERIAL WILL BE COVERED IN LECTURES. The Lecture-Notes Book makes reference to the text and which sections are to be regarded as part of the course. It is the responsibility of each student to ensure that he/she is familiar with this material.

- *You cannot expect to progress comfortably through the course without consistent attendance at lectures and tutorials, and completion of all tutorial problems, assignments and the mid-term.*  
Please be aware that as a second-year course, 208 requires considerably more work than 108.
- If you feel unsure about the suitability of your preparation for the course, please contact either your current lecturer or the course-coordinator to discuss your options.
  - The last day for deletion of a course is the second Friday of the semester.
  - If you withdraw from the course after that date in less than exceptional circumstances, you must do so by the end of the ninth week of the semester. The course will then remain on your academic record and show as a withdrawal. There will be no refund of fees in this case.

**CECIL** CECIL is the prime means of information about the course. All announcements made in lectures will also be made on CECIL. Students are requested to log on to CECIL on a regular basis, and use it to get information about the course, about assignments, about any matters concerning rooms, resources, or assessments. Access Cecil at <http://www.cecil.auckland.ac.nz>

**Class Notices** Announcements sent via Cecil are simultaneously sent to your **University Webmail** address. Log onto NetAccount from any university computer with your netlogin and netpassword to access your University Webmail at <https://webmail2.ec.auckland.ac.nz/webmail.html>.

You can *redirect your University webmail* by logging onto NetAccount and then going to <https://admin.ec.auckland.ac.nz/emailRedirection/>. You are advised that many essential notices are sent via Cecil through the semester - it is your responsibility to read these notices either via Cecil or your University Webmail.

If for any reason during the semester you are *locked out* of Cecil, you can view course materials and notices by logging on to Cecil as a “pin user”:

Click on the “pin user” icon on the Cecil login page, and then log in with the username maths208, and password maths208. This will bring up all the course-materials and notices of the current semester for Maths 208.

**Lecture Presentations** All lecture presentations will be derived from the Lecture Notes Book. Students not attending lectures can obtain the text references from the Lecture Notes.

**Tutorials** Weekly tutorials start in the *first* week of the semester: Thursday March 1.

It is essential that you attend the tutorials and participate, to consolidate your learning and to prepare for doing the assignments. Tutorial answers (not worked solutions) will be available from Cecil the Friday of *the week after* the tutorial.

**Assignments** There will be 4 assignments through the semester.

These give important practise in the problem-solving methods and concepts dealt with in the course. They will be made available on Cecil the Thursday of the week before they are due, and are due in the boxes outside the Student Resource Centre. Assignments will generally be marked within a week.

Assignments handed in to the wrong box, or handed in late, will not receive credit. *You are forewarned!*

Assignment	available on Cecil	date due (at 3pm)
Assignment 1	Thursday 8 March	Friday 16 March
Assignment 2	Thursday 29 March	Thursday 4 April
Assignment 3	Thursday 3 May	Friday 11 May
Assignment 4	Thursday 17 May	Friday 25 May

As solutions to assignments are made available on Cecil the Monday after they are due, (re)submission of coursework after due-dates is not permitted.

**Mid-Term Test** There will be one one-hour test held on Friday 27 April from 6:30-7:30pm.

The test will cover Calculus and tentatively Linear Algebra up to sec 4.6 of the Lecture Notes.

**Final Exam** The University will announce the final exam timetable about 4 weeks into the semester. You will be notified on Cecil. Rooms for the final exam are only made available the night before the exam date. You should consult notices placed around campus at the appropriate time for the location of your final exam.

**Coursework Mark Discrepancies** If there is any discrepancy between your course-work marks (assignment or mid-term) and those which appear on Cecil, please take the relevant marked work to the SRC in the basement of building 303 and have them rectify it.

**Assessment** Final grades for this course will be based on the plussage system:

EITHER 20% from the test, 10% from the 4 assignments, and 70% from the final exam

OR 100% from the final exam.

To qualify for the 100% final exam option, however, students must

- obtain an average of at least 40% on their four assignments, and
- sit the mid-term test.

**Collaborating & Cheating** You are encouraged to discuss problems with one another and to work together on assignments, but you must not copy another person's assignment. Assignment marks contribute to the final mark you receive in this course. We view cheating on assignment work as seriously as cheating in an examination. Generally acceptable forms of collaboration:

- Get help in understanding course-material from staff and tutors – you are encouraged to ask for help.
- Discussing assignments and methods of solution with other students.

Generally unacceptable forms of collaboration (“cheating”):

- Copying all or part of another student's assignment, or allowing someone else to do all or part of your assignment for you.
- Allowing another student to copy all or part of your assignment.
- Doing all or part of an assignment for somebody else. This is treated as seriously as copying another student's assignment.

If you are in any doubt about the permissible degree of collaboration, then please discuss it with a staff member.

**Getting Further Help** For assistance with the material covered in the course:

- Ask about the material in the tutorials.
- Get help and advice from the tutors in the Assistance Room in room B25 in the basement of the Mathematics Building. It will be open on weekdays from 10am to 4pm, starting in week 2.
- Visit the lecturer in his/her office during office-hours. Office hours will be announced in class, and posted on Cecil.
- The Student Learning Centre (SLC) in the Information Commons offers some one-to-one assistance. You pay \$10 to join the SLC and this entitles you to book SLC assistance for the entire calendar year.

For assistance in any other matter, please contact the Course Coordinator, Anita Kean (a.kean@auckland.ac.nz).

**Harassment & Complaints** Complaints about assignment or tutorial marks are best taken to your lecturer who is in a position to do something immediately. More general complaints can be taken up by your class representative who should be elected or appointed in the first couple of lectures. You may also approach the Head of Department or the Departmental Manager for Mathematics (extension 88063). Harassment on any grounds, such as racial, sexual, religious and academic is totally unacceptable. Complaints about harassment are best taken to the University Mediator (extension 87478) or to any member of the Resolve Network whose names are displayed on posters around the campus.

Welcome to Maths 208. We hope you enjoy the content of the course, and the challenge it offers.

Anita Kean, Room 323 Maths, xt 88742.